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A NEW APPROACH FOR ESTIMATING ENTRAINMENT RATE IN CUMULUS

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ABSTRACT

Entrainment of dry air into clouds is essential to many cloud processes, but is still poorly understood and represented in atmospheric models. In an effort of the FASTER project to integrate aircraft measurements into model evaluation and parameterization development, here we present a new approach for estimating fractional entrainment rate of cumulus clouds with aircraft observations. This approach is based on the definition of entrainment rate and the mass ratio of the adiabatic cloudy air to the dry air entrained during the ascent from cloud base to an aircraft horizontal penetration altitude. The essence of this method is that the mass ratio is not calculated directly from the air masses, but is determined indirectly from the microphysical and thermodynamic information along the aircraft observation leg. In the traditional method, at least two aircraft horizontal legs are needed whereas the new method only requires one aircraft horizontal leg along with a proper estimation of cloud base altitude. This new method will be an alternative way to estimate entrainment rate, especially when only one aircraft horizontal leg is available. We will introduce the new approach, and validate it by comparing entrainment rates obtained with the new method and previous studies. We will also explore the potential to apply the new approach to evaluate parameterized entrainment rates, and seek connection to cloud microphysics.